Unit 3A: Neural Processing and the Endocrine System

I. Introduction
   A. You cannot totally separate the mind from the body.
   B. **Biological psychologists** study the linkage and interplay between the body and the mind.
   C. Even more broadly, there is a **biopsychosocial** component. This concept believes we do the things we do because of (1) our bodies, (2) our minds or thinking, and (3) the culture that we live in.

II. Neurons
   A. **Neurons** are nerve cells. There are a few types to know…
      1. **Sensory neurons** – Take messages from the body, up the spinal cord, to the brain. There are millions of these.
      2. **Motor neurons** – Take messages from the brain to the body. There are millions of these.
      3. **Interneurons** – Are neurons within the brain that "talk" to one another while thinking or processing information. There are billions and billions of these.
   B. Parts of a neuron
      1. **Cell body** with a nucleus in the middle.
      2. **Dendrites** are feather-like fingers sticking out from the cell body. They bring info in to the cell.
      3. **Axons** are long "arms" that send info away from the cell body to other neurons or body parts.
         a. Axons are insulated by the **myelin sheath**. This insulation helps control the impulses and speeds their travel.
         b. Messages travel along neurons at between 2 and 200 mph (depending on the type of neuron). This may seem fast, but is very slow compared to computers.
      4. Neurons "fire" when stimulated by a sense or other chemicals from another neuron. When it fires, it's called the **action potential**. This is a slight electrical charge.
         a. A chemical reaction generates the electricity, like with a battery.
         b. This is an all-or-nothing event, the neuron either fires or it doesn't fire.
         c. Axons have negatively charged ions *inside*, positively charged ions *outside*. There is a *selectively permeable* membrane in between (it selects what to let in/out).
         d. When firing, a neuron allows the positive ions in. For a moment called the *refractory period*, it can't fire, until it pushes the positive ions back out and "resets" itself.
         e. Neurons get mixed signals. *Excitatory* signals tell it to fire. *Inhibitory* signals tell it to not fire. When the excitatory signals outweigh the inhibitory signals by a certain amount, the neuron fires. This is called the **threshold**.

III. How neurons communicate
   A. A **synapse** is the place where the axon of one neuron meets the dendrites of another. There is a very slight gap in between (the "synaptic gap").
   B. **Neurotransmitters** are chemical messengers that take the impulse of one neuron across the synaptic gap to another neuron.
      1. During what's called reuptake, the extra neurotransmitters return to the original neuron and are ready again.

IV. How neurotransmitters influence us
   A. Neurotransmitters affect people in many ways such as: depression, happiness, hunger, thinking, addictions, and therapy.

B. An example is acetylcholine (ACh). ACh tells muscles to contract. When it's blocked (as in some anesthetics), the muscles won't contract and we're paralyzed.
C. Another example is **endorphins**. These are like natural morphine that our bodies produce. They improve our moods and reduce pain. They're released either in times of pain or heavy exercise.
    1. When a person uses drugs like cocaine, heroine, or morphine, the body will produce less endorphins of its own.
    2. Drugs that act like neurotransmitters and bridge the synaptic gap are called *agonist molecules*. Opiate drugs produce a "high". Black widow spider poison produces muscle spasms.
    3. Whereas agonists *connect* the synaptic gap, *antagonists* block transmission. For example, Botox blocks a muscle from contracting.

V. The peripheral nervous system
    A. People are said to have two nervous systems:
        1. The **central nervous system** consists of the brain and spinal cord.
        2. The **peripheral nervous system** consists of our sensory receptors, muscles, and glands.
    B. The peripheral nervous system has two parts:
        1. The **somatic nervous system** can be voluntarily controlled, like moving your legs.
        2. The **autonomic nervous system** runs on its own, like your heartbeat. The autonomic nervous system also has two parts:
            a. The **sympathetic nervous system** which activates and exerts energy – like preparing to run away or to fight. Specifically, it increases your heartbeat, blood pressure, blood sugar, and slows digestion. It gets you ready for action.
            b. The **parasympathetic nervous system** kicks in when the "crisis" is over – it calms you down by doing the opposite things. It helps you chill out.

VI. The central nervous system
    A. Our bodies are amazing, but without the brain, we're like robots. The brain is what makes us human. 400 trillion synapses "talk to one another" in our brains.
    B. Neurons group themselves together into *neural networks*. This helps them communicate even faster.
    C. The **spinal cord** connects the brain with the peripheral nervous system. Reflexes are a good example of sensory information going to the brain and motor information going from the brain to a muscle.
        1. A single sensory neuron and a motor neuron working together form an *interneuron*.
        2. A person whose spinal cord is cut and is paralyzed still has the knee-jerk reaction. The brain is not involved with an interneuron.

VII. The endocrine system
    A. The endocrine system secretes **hormones** which impact interest in sex, food, and aggression.
    B. Like neurotransmitters, some hormones have molecules that act on receptors in the body. Hormones move slower than neurotransmitters, but last longer.
        1. For example, suppose you think you're about to get into a fight. The **adrenal glands** secrete epinephrine (AKA adrenaline). It increases the pulse, blood pressure, and blood sugar.
        2. After the crisis is over, it takes a
        3.
        4. while to calm down and return back to normal.
    C. The **pituitary gland** is the most influential. The pituitary is controlled by the hypothalamus part of the brain. The pituitary's hormones influence growth and secretions by other glands (it's the "master gland"). These hormones, in turn, then influence the brain.

1. The chain-reaction could be represented as: Brain->Pituitary->Other glands->Hormones->Brain

Unit 3B: The Brain

I. Introduction
   A. There's little doubt that what makes you yourself and me myself resides in our brains.
   B. The mind is somehow a combination of body plus brain.

II. The tools of discovery: having our head examined
   A. Early on, there were no tools to "map" the brain. Damages to the brain and resulting symptoms enabled researchers to build a rough "brain map".
   B. Today, we have several techniques to measure brain activity.
      1. Areas of animals brains can be destroyed and the results analyzed. Or, brain areas can be stimulated and the results analyzed.
      2. An **EEG** (**electroencephalogram**) is a read-out of electrical brain activity.
      3. A **PET scan** (**positron emission topography**) shows the brain's "hot-spots" of action by measuring its consumption of sugar glucose, the brain's fuel.
      4. An **MRI** (**magnetic resonance imaging**) provides a picture of the brain's soft tissue. MRI's have shown brain differences in things such as people who have perfect pitch or schizophrenia.
      5. An **fMRI** (**functional MRI**) can show the brain's structure *and* function. An fMRI measures blood-flow to and within the brain and therefore can show brain activity.

III. Older brain structures
   A. Brain size-to-body weight ratio is important to an animal's intelligence, but it isn't the *only* factor of intelligence.
   B. Simple animals, like sharks, have brains that are concerned with survival—breathing, resting, eating. In mammals and especially in humans, higher order brain functions emerge, like emotion and memory.
      1. Thus, we have two brain functions: "old brain functions" dealing with survival and more complex brain functions dealing with thought.
   C. The **brainstem** is the oldest brain region.
      1. The brainstem begins as the spinal cord enters the brain it swells in width. This section is called the medulla. The **medulla** controls heartbeat and breathing.
      2. Above the medulla is the **pons**. It helps to coordinate movements.
      3. The **reticular formation** is inside the brainstem. It looks a bit like folded fingers and relays incoming stimuli to other areas of the brain (also regulates autonomic functions, such as arousal.)
   D. Atop the brainstem is the **thalamus**. It's the hub that sends incoming sensory impulses (except for smell) to the higher brain areas.
   E. The **cerebellum** is at the back of the brain. It's baseball size, is split into two parts, is wrinkled in appearance, and means "little brain" which is what it looks like.
      1. The cerebellum coordinates movement, manages emotions, and figures out sounds and textures.
   F. The **limbic system** sits between the older brain structures and the cerebral hemispheres (the two large halves of the brain).
      1. The **hippocampus** is critical because it processes memory.
      2. The **amygdala** is made up of two bean-size nerve bundles. The amygdale manages anger and fear. It also is involved with handling the emotions and memories involved here.
         a. It's important to note something here—we like to categorize things, such as A does B, and X does Y exclusively. The brain, however, is far more complex. Several parts of the brain handle things like emotions, memories, learning, movement, etc.

3. The **hypothalamus** ("hypo" meaning below) is below the thalamus. The hypothalamus is important in hunger, thirst, body temperature, and sexual behavior.
    a. As an example, thinking about sex in the cerebral cortex activates the hypothalamus. It emits hormones that affect the pituitary (the master gland) which affects other hormones to. These hormones influence brain activity. Remember the chain: Brain->Pituitary->Other glands->Hormones->Brain
    b. As another example, a chance discovery had two scientists implant an electrode in a rat's "reward" or "pleasure center" of the brain—the hypothalamus. This spawned experiments. Rats would similarly press a lever to give a reward to its brain, up to 7,000 times/hour, until it stopped from exhaustion.
        i. Later rats were essentially driven, remote controlled, to turn left or right by pleasure impulses to their hypothalamuses.
    c. Animal research shows a release of dopamine within pleasure areas of eating, drinking, and sex.
    d. People have shown mild, but not the same, frenzied results as the rats.

IV. The cerebral cortex
A. Whereas the older brain parts carry out survival functions and less voluntary things, the newer brain parts deal with more voluntary functions, like perception, thinking, and speaking. The **cerebral cortex** is the largest section of the brain, about 85% of its weight. It's the gnarled "bark" that encompasses the rest of the brain.
B. Being wrinkly, the cerebral cortex looks like a giant walnut. It has about 20 to 23 billion nerve cells linked together by 300 trillion synapses.
    1. These nerve cells are supported by 9 times as many **glial cells**. These cells feed and insulate the nerve cells.
C. The cerebral cortex is divided into four lobes, separated by fissures, and each with their own specialties…
    1. The **frontal lobe** is in the front, behind the forehead.
    2. The **parietal lobe** is at the top and to the back of the brain.
    3. The **occipital lobe** is at the back and bottom of the brain.
    4. And the **temporal lobe** is near the temples, on the side.
D. The cerebral cortex has different functions centered on different areas.
    1. The **motor cortex** is a strip roughly between the frontal and parietal lobes. It handles our movements and motions by sending impulses from the brain to the body. Tests where electrical stimulation to this part of the brain would make animals or people move in various ways.
        a. The question then became, "Could a person or animal control a machine (like a computer mouse) using his brain?" The answer seems to be, "Yes." A monkey was "wired up" to control a mouse with only his motor cortex.
        b. Researchers are trying to use this technique with a paralyzed person who cannot speak. The idea is to "wire up" the cortex to a machine, the person thinks of the word, and the machine speaks for him.
        c. The FDA gave the okay for a "neural prosthetic" in 2004. With a computer chip implanted in his motor cortex, the man could control a TV, draw shapes on a computer, and play video games.
    2. Sensory functions
        a. The **sensory cortex** receives input from the senses to the brain (the opposite direction from the motor cortex). The sensory cortex

is a strip just behind the motor cortex, at the front of the parietal lobe.
        i. The more sensitive the area of the body (like the sensitive lips), the larger that area of the sensory cortex.
    b. The **occipital lobe** processes vision. Being bonked in the back of the head can literally have you "see stars" or flashes because the lobe gets jarred.
    c. Sounds are processed in the auditory cortex in the temporal lobe (appropriately, just above the ear).
3. The areas described thus far in the cerebral cortex make up only about ¼ of its size. The other ¾ of the cortex is harder to pin down and label, but seems that it's for thinking. It's generally called **association areas**. These areas piece parts together and make sense of things.
    a. For instance, seeing a stick of dynamite and a lit match side-by-side mean nothing until they're associated with one another. The logical conclusion – danger!
    b. The frontal lobe handles judgment, planning, and new memories.
        i. It also impacts personality. Phineas Gage was famously injured in a railroad accident in 1848 when a iron spike drove through his skull. It injured his frontal lobe. He was largely okay, but his personality had changed completely from friendly and mild-mannered to profane, cranky, and dishonest.
    c. The parietal lobe seems to handle math and spatial reasoning (Einstein's were large) as well as recognize faces.
    d. Despite these hot spots, the brain's "map" really isn't written in stone and we should be careful to not think that it is.
4. The brain has a measure of **plasticity**, that is its ability to change itself after being damaged.
    a. Whereas something like skin can "grow back" or "heal over," neurons don't regenerate themselves. A severed spinal cord stays severed. But the brain seems able to reorganize or reassign jobs and functions.
    b. Children's brains are amazingly plastic.
    c. People seem to heal fastest when their "good hand is tied behind their back" and are forced to use their "bad hand." This forces the brain to reorganize.
    d. There are many examples…
        i. Blind people who read Braille have increased sensitivity in their fingertip.
        ii. Deaf people's hearing area of the brain turns toward visual stimulation.
        iii. A lost finger's area of the brain will take on the nearby fingers' sensation.
    e. Contrary to popular belief, we do grow new brain cells in a process called **neurogenesis**. Naturally, this is promoted by exercise, sleep, and non-stressful but stimulating environments.

V. Our divided brain
    A. We've known for over 100 years that the two sides of the brain have different purposes. Damage to the left hemisphere resulted in problems with reading, writing, speaking, math, and reasoning. Around 1960, it was discovered that the right hemisphere had its specialties as well.
    B. In 1961, patients with severe epileptic seizures had their **corpus callosum** cut. The corpus callosum links the two hemispheres. The seizures stopped and the patients were very normal afterwards.

1. These patients were then subject to experiments. The patient stared at the center of a screen and words or images were sent displayed to each side and thus were sent to one half of their brain. For example…
2. HE . ART was flashed while staring at the center dot. HE went to the right brain, ART to the left brain. When asked what he saw, he said "ART" (left brain talking). Then he pointed to HE with his left hand (right brain controlling).

C. Left brain – right brain research can get very confusing with its criss-crossing nature, but the overall conclusions were…
1. The <u>left brain handles rational, logical thought, speech and words</u>. Think of Mr. Left, a boring, methodical, math teacher who carefully works through complicated problems step-by-step and always gets the correct answer.
2. The <u>right brain handles images, emotions, intuition, and drawing inferences</u>. Think of Mrs. Right, a flaky, unpredictable art teacher who can instantly tell when you're having a down day.

VI. Right-left differences of the intact brain

A. For nearly all people (those who *don't* have a severed corpus callosum) the hemispheres "talk" to one another instantly. Still, the halves have their specialties.
1. A sedative to patients that goes to the left brain will leave the person's right arm limp and they can't speak.
2. A sedative to patients that goes to the right brain will leave the person's left arm limp but they can still speak.
3. Sign language is also dominated by the left hemisphere. One might think the right hemisphere would handle this (being more spatial and visual in nature), but not so. Language is language regardless of how it is conveyed.
4. The right hemisphere handles our sense of self – who we are and how we look.

B. 90% of people are right-handed. 96% of these folks process speech in the left hemisphere. But, only 70% of left-handers process speech in the left hemisphere.
1. Left or right handedness seems to be genetic in some way.
2. Left-handers have more reading disabilities, allergies, and migraines. But they seem better than righties at music, math, and art.

C. These facts illustrate the overall theme of this chapter – biology influences everything psychological.

Unit 3C: Genetics, Evolutionary Psychology, and Behavior

I. Introduction
   A. People are both very different in many ways and very similar in many ways.
   B. Some things seem universal to people, regardless of their race or culture – perceiving facial expressions, building relationships, conformity, formation of social rankings, grieving, celebrating, worshiping, and playing.

II. Genes: our codes for life
   A. Every cell in our bodies holds our master genetic code. This is in our **chromosomes** – a normal person has 46 chromosomes, 23 from our mother and 23 from our father.
   B. Chromosomes hold our **genes** which holds our **DNA**, our genetic coding.
      1. Genes are either active or inactive, "expressed" or "repressed".
      2. People are remarkably similar genetically, regardless of race or ethnicity.
      3. Geneticists are interested in those few differences, however, that make us so different.

III. Twin and adoption studies
   A. Studying genetics of humans brings up many ethical questions. Experiments are really not an option. So, researchers turn to twins and adopted children.
   B. The question centers on the nature-vs.-nurture discussion – which is more powerful?
      1. Twins can have identical genes but might be raised in different environments. Any variations or similarities then would be influenced by genetics.
      2. Adopted children can have different genes but be raised in a very similar environment. Any variations or similarities then would be influenced by the environment.
   C. There are several groups we're interested in here…
      1. **Identical twins** which have identical DNA since they formed from a single **zygote** (fertilized egg). They have identical DNA and their environment is very similar – they have the same birthday, often share the same room, start school at the same time, experience things like moving to a new home at the same age, etc.
      2. Fraternal twins are simply siblings formed from two zygotes. Their genetics are not identical but are close since they're siblings, and like identical twins, their environment is very similar.
      3. **Siblings** who are simply brothers/sisters or both. Being siblings, they have close genetics. But, since they're normally at least one year apart in age, usually more, they have a slightly less common environment. Changes and experiences happen at different ages and thus may have differing influences.
      4. "**Virtual twins**" are non-related children of the same age, like step-brothers or step-sisters. Being non-related, genetics are no more similar than any two people. But being virtual twins, the environment is very similar.
   D. The research seems to show that genetics play the larger role in the nature-nurture battle. The more close the genes, the more close the people. The "ranking of similarity" then, from most to least similar, is…
      1. Identical twins raised together.
      2. Identical twins raised separately. There have been freakish similarities.
      3. Fraternal twins raised together.
      4. Siblings raised together.
      5. Siblings and fraternal twins raised separately.

6. Virtual twins raised together.

E. With the "power of genes" evident, what's the role of the environment? The research shows that the way a child is raised matters in a huge way.
    1. Genetics influence personality and physical attributes (but so does the environment, such as a junk-food family or a health-food family).
    2. The environment influences things like attitudes, beliefs, religion, politics, and manners.
    3. Adopted children thrive in their adopted homes.
        a. Adoptive parents are screened thoroughly. Thus, they're likely to be better educated parents and live more stable lives – good things for children.
        b. Adopted children often "do better" and score higher on IQ tests as compared to their biological siblings who stay with their biological parents.

IV. Heritability
- A. **Heritability** is the mathematical likelihood that differences between people is due to genetics.
    1. This does not show the likelihood that the genes caused a certain trait.
    2. This shows the percent likelihood of *variations among people* based on genetics.
- B. Heritability depends on how alike or unlike two people's environments are.
    1. If two people grow up in an exactly similar environment, heritability is high. This is because any differences are likely due to genes.
    2. If two people grow up in very different environments, heritability is low. This is because any differences may very well be due to the environment rather than genes.
- C. It's likely inaccurate to apply an individual's heritability to groups of people as a whole.

V. Gene-environment interaction
- A. It's only fair to say that both genetics and the environment *interact* to create who we are. From the day we're born, our environment shapes us.

VI. The new frontier: molecular genetics
- A. **Molecular genetics** tries to single out how specific genes influence the body or behavior. Examples might be genes that govern body weight or how outgoing a person is.
- B. To single out these genes, researchers start with families that have a trait that runs through generations, say alcoholism. They take blood samples or cheek swaps. Then they compare their genes with those of "normal" people and look for differences.
- C. Because we can "see into the future", ethical issues arise.
    1. Millions of female fetuses are aborted in China and India because males are more desired.
    2. Fetuses might have a problem that shows up in their DNA. Many debate whether it would be okay to abort that pregnancy.
    3. Some wonder, if parents don't like the child's genetic make-up, is it okay to abort the child and "try again"? What if the DNA shows a brown haired child and the parents wanted a blonde, okay then?

VII. Natural selection and adaptation
- A. For all the mileage he got out of it, **Charles Darwin**'s 19th century **theory of evolution** is rather simple. The theory holds these beliefs…
    1. A species has variations.
    2. Those variations sometimes help it to live and/or to reproduce.
    3. If it lives and reproduces, its genes get passed on to the next generation (those that did not live and reproduce, will not get passed on).

B. Some researches wondered how long it would take to domesticate a fox. After 30 generations of breeding the most tame fox-parents (forty years), the result was a loving and affectionate fox.
C. The evolution theory believes that genetic **mutations**, <u>random chance changes</u>, sometimes help a species to survive and/or reproduce.
D. The evolution theory believes that humans have both genetic changes as well as the ability to use our minds and change ourselves to our environments.

VIII. Evolutionary success helps explain similarities
A. Regardless of face, humans are genetically at least 95% similar.
B. People love to eat junk food – fatty and sweet food that makes us fat. In the old days, these treats were rare, but they staved off famines.

IX. An evolutionary explanation of human sexuality
A. Men and women are different, in case you hadn't noticed.
1. Men are seen as seeking sex more often than women.
2. Women are traditionally seen as viewing sex as a relationship (that they are in it for the long haul).
3. An evolutionary psychologist would say, "A man wants to spread his genes as often as possible (have a lot of sex), but a woman wants a man that sticks around to help raise the kids."
B. Men find women attractive who are young (20s), healthy-looking, athletically built, and smooth-skinned. These things add up to several child-bearing years ahead.
C. Women are attracted to somewhat older men – those who are mature, dominant, confident, like a successful businessman.

X. Critiquing the evolutionary perspective
A. Evolutionary psychology is often criticized as being somewhat narrow-minded. It perceives people as acting under one, and only one, impulse – the desire to survive and pass on genes.
B. Many wonder, "As human beings, isn't there something more to us than this animalistic drive?"

XI. Reflections on nature and nurture
A. Simply put, both our genes and the environment in which we're raised both make us who we are.
B. Our genes deal us our cards, the environment influences how we play those cards.